Time, complexity, and self-organization in collaborative governance networks

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Abstract

The growth of collaborative environmental governance has resulted in increasingly complex policy and management landscapes, where actors are presented with numerous decision-making venues they can participate in, and numerous other actors they can collaborate with. Recognizing cognitive limitations and other resource constraints, the benefits of engaging with multiple venues and other actors should however saturate at some level of engagement. Who actors choose to collaborate with and which venues they attend thus reflect what they perceive to be the best strategies for achieving their policy objectives, given these constraints. Drawing on the ecology of games framework, this article investigates the structures of two empirical governance networks from Sweden that emerged as a result of the decisions actors made regarding how to collaborate to address complex policy issues and management tasks. The findings suggest governance networks self-organize according to tradeoffs in formation time and the number of policy issues and/or management tasks actors engage with. We find that the saturation in the number of collaborators and venues actor engage with occurs at higher levels in governance arrangements that evolve over longer times.

Keywords: collaborative environmental governance, ecology of games, self-organization, social network analysis, time-complexity tradeoff

1. Introduction

The growth of collaborative environmental governance has resulted in increasingly complex and interconnected policy systems (McAllister et al. 2013, Lubell 2013, Berardo 2014), characterized by an array of participatory decision-making venues and involving many diverse public and private actors (Bodin and Crona 2009, Lubell et al. 2014). Engaging with venues and other actors is necessary for achieving influence and advancing one's own policy and management objectives (Pralle 2003, Mintrom and Norman 2009, Sabatier and Weible 2014), and collaborative governance arrangements provide actors with more opportunities to engage in cooperation, knowledge sharing, resource mobilization, and other social processes to help further their goals (Ostrom 1990, Berkes and Turner 2006, Lubell 2015). However, the complexity of real-world governance settings also presents actors with a number of difficult decisions about how best to allocate venue participation and network with other actors given limitations on personnel, funding, and cognitive resources (Lubell 2013, Berardo and Lubell 2016). Understanding the factors shaping actors' decisions to participate in venues and collaborate with other actors is important for addressing collective-action problems in environmental governance, where the benefits of policy and management actions across fragmented institutions often fail to accumulate (Lubell et al. 2010). To address these issues, this article draws on two empirical datasets from Sweden to investigate how the structure of networks for governing social-ecological systems are influenced by tradeoffs in time and complexity actors are faced with when deciding how to engage with venues and other actors.

Collaborative governance has emerged worldwide over the past few decades as an alternative to traditional forms of more centralized, top-down environmental management (Ostrom 1990,

Ansell and Gash 2008), and has been theorized to provide a number of benefits, including expanding participation and inclusion of marginalized actors, increasing the perceived legitimacy of governance processes, fostering social learning, and facilitating the creation of social capital and trust (Pretty and Ward 2001, Folke et al. 2005, Pahl-Wostl et al. 2007, Birnbaum et al. 2015). However, collaborative governance does not guarantee improved social and/or ecological outcomes (Koontz and Thomas 2006), and the increasing interconnectedness and scale of global environmental issues further complicates the challenges inherent in complex policy systems. Determining who to collaborate with in order to create social ties, build coalitions, and form working partnerships is not easy, as building relationships requires considerable time and effort. How actors decide to collaborate is an increasingly important topic to both researchers and practitioners; given the uncertainty and complexity of social-ecological system dynamics, understanding how actors interact with, and shape, the governance systems they are a part of can be used to recommend policies for supporting institutional adaptation and resilience (Folke et al. 2005, 2016). Similarly, the increase in boundary-spanning issues and expansion of venues means the process of determining how to allocate participation is also costly, and might lead to actors' resorting to less-committal "venue shopping" (Pralle 2003). This suggests two parallel but intertwined network activities, both of which are necessary for actors to effectively advance their policy and management objectives and influence the decision-making process.

We propose a tradeoff, in the form of a time-complexity mechanism, that influences how actors choose to engage with venues and other actors. Further, we propose that engaging with many actors and engaging in multiple venues essentially draws from the same pool of resources. Drawing on the ecology of games framework (Long 1958, Lubell 2013), we use social network analysis to investigate how the process of self-organization in governance networks is affected by the time over which the system evolves and the complexity of the social and ecological challenges actors are faced with. Specifically, we examine the relationship between the social activity of actors – i.e., the number of collaborative ties they have with other actors – and the number of policy issues and management tasks actors engage with. The causal relationship may run in both directions, and the focus of our analysis here is on whether there is an association between social activity and venue engagement as a function of the time over which governance networks form. As governance networks evolve over longer periods of time, we expect actors to be more willing to engage with more actors and venues.

By focusing on how actor participation in decision-making venues and collaboration with other actors are influenced by constraints imposed by network formation time and various resource constraints, this paper makes several important contributions to the literature on environmental governance networks. In spite of the ecology of games framework providing a common model for studying the relationship between actors and venues in polycentric governance systems, empirical studies examining both collaboration among actors and actor participation in venues are a very recent contribution to the governance literature (Bodin and Nohrstedt 2016, Scott and Thomas 2017), while previous studies have focused mainly on actor-venue relationships (McAllister et al. 2013, Lubell et al. 2014, Berardo et al. 2015, Jasny and Lubell 2015). Our analysis further contributes to the ongoing revival of the ecology of games framework, and reinforces its broad utility for understanding the process of institutional self-organization in diverse social-ecological systems. Lastly, we synthesize existing empirical research to highlight a general trend in the social activities of actors that suggests collaborative environmental governance networks self-organize and evolve according to tradeoffs in time and the complexity of policy landscapes characterized by the existence of multiple venues.

2. Theory

2.1 Benefits and constraints of actor and venue engagement in an ecology of policy games

By recognizing the co-existence of many decision-making venues in real-world environmental governance settings, and focusing on the interactions occurring among actors participating in these venues, we are explicitly drawing on the concept of an "ecology of games" to frame our analysis. The idea of the ecology of games was originally developed by Norton Long (1958) as a means for framing the complex interrelations between distinct, often overlapping, processes occurring in society (e.g., media, banking, manufacturing). Lubell et al. (2010, 2014) have since resurrected and updated the framework for quantitative analysis of environmental policy systems, and its relationship to governance is thus explicated by Lubell (2013, p.538): "governance involves multiple policy games operating simultaneously within a geographically defined policy arena, where a policy game consists of a set of policy actors participating in a rule-governed collective decision making process [i.e., deliberation taking place in venues]…" Using network analysis as a means of implementing the ecology of games framework, our aim is to understand how time and complexity influence the process of self-organization among actors and venues involved in governing diverse social-ecological systems.

A large body of literature has developed around the study of self-organization in collaborative governance arrangements (e.g., Folke et al. 2005, Ostrom 2009, Berardo and Scholz 2010, Berardo and Lubell 2016, McAllister et al. 2017), yet few studies have specifically examined how limited cognitive resources and related constraints affect the capacity of actors to engage with multiple venues and other actors in governance networks. Many of these studies also implicitly treat actor collaboration and venue participation as separate and unrelated processes by focusing on one or the other, yet they are complementary approaches to governance and conceptually similar, drawing upon the same set of basic resources. These two network activities provide opportunities for actors to engage in collective action and develop integrated solutions to complex social-ecological problems (Carlsson and Sandström 2008, Bodin and Crona 2009), which no single actor or institution can address in isolation. However, participating in venues and collaborating with other actors are not identical processes and are not interchangeable, and we argue being linked to multiple actors and venues is necessary for effectively advancing one's policy and management goals.

Venues are a structured decision-making space, guided by a set of rules or norms, where actors are able to interact, deliberate, and implement management activities (Lubell 2013). Participating in venues is one of the primary ways for actors to advance their policy and management goals within a given social-ecological system, yet before actors can participate in venues they must first decide which venues to attend. Venue shopping refers to the process of investigating and identifying the venues where actors believe their policy objectives will have the greatest influence (Pralle 2003, Weible 2007), and has a rich history in the broad literature on public policy (Sabatier and Jenkins-Smith 1993, Baumgartner and Jones 2010, Henry et al. 2014, Varone et al. 2016). Both venue shopping and participation require substantial time and effort, and while engaging directly with more venues may increase the attention given to an actors' policy goals, it may reduce the time actors are able to spend advocating for their goals in any one venue, as well as time that could be spent collaborating with other actors. However, participating in few venues may mean actors are not able to address all their specific policy goals, and may also diminish an actor's influence in policy and management decisions.

Multi-actor collaboration is important for addressing environmental problems that span political and administrative boundaries (Bodin et al. 2016a), as well as for building support for the specific policy and management issues actors advocate for in venues (Sabatier and Jenkins-Smith 1993). While venues are places where actors and coalitions meet and interact, we assume most networking among actors occurs outside of venue meetings, as it is more effective to articulate policy and management objectives and build coalitions before the formal decision-making events. Nonetheless, partaking in venues provides actors with opportunities to engage with others, and they also provide the actors with concrete rationales for engaging with certain others. Similar to venue shopping, seeking out and establishing collaborative relationships with other actors requires considerable time and effort. Actors participating in many venues may have more influence in the governance arrangement, but may also be perceived as unavailable and less desirable as partners. Conversely, actors participating in few venues may be viewed as less adept at dealing with complex social-ecological issues, or as having less influence in the decision-making process.

In spite of the inherent costs of engagement, it is generally beneficial being linked with multiple actors and venues, as each additional actor and venue that actors engage with can provide benefits in the form of increased opportunities for collaboration, and access to information and other resources (Fig. 1a). We further argue the utility of these connections is interactive, since another benefit of social ties with other actors is additional support and influence when engaging in venues. Therefore, the total utility of a social tie depends on how many venues an actor is engaged in – for an actor participating in multiple venues, the increase in influence of an additional social tie plays out across all the venues. Taken together, this means that the utility (U) of each additional actor (A) and venue (V) may be expressed as:

$$U = A + V + A*V \tag{1}$$

However, it is not a feasible strategy for actors to try and participate in every venue or collaborate with every other actor, as actors in real-world governance arrangements are confronted with limitations on cognitive resources, funding, and personnel. These constraints impact actors directly in the costs associated with venue participation, and in collaboration with other actors. Assuming that engaging with actors and venues draws from this same pool of finite resources, the number of actors and venues cannot exceed the capacity (C) of each individual actor to manage these relationships without becoming inefficient:

$$A + V \leq C \tag{2}$$

Combining the two equations above[1], we find that utility is maximized when actors engage with an equal number of venues and other actors,

$$A = V = C / 2 \tag{3}$$

and that this relational utility may be expressed as a function of an actor's capacity and the number of other actors (or venues) an actor engages with:

$$U = C + A*C - A^2 \tag{4}$$

[1] We replace V in (1) with $V = (C - A)$ from (2) to form (4). We then take the derivative of (4) with respect to A, and set it to zero to find the peak value (3).

This expression of relational utility takes the form of an inverted U-shaped curve, and demonstrates there is a saturation point in the number of actors (or venues) that a given actor may engage with efficiently before the utility of forming additional relationships decreases (Fig. 1b). The peak of the curve is defined by an actor's capacity, which may vary from actor to actor, and may be further influenced by characteristics of the governance system (e.g., the number and nature of the particular social and ecological challenges). In the following sub-section, we expand on this theoretical and conceptual foundation to discuss how actors' capacity to engage with venues and other actors may be enhanced.

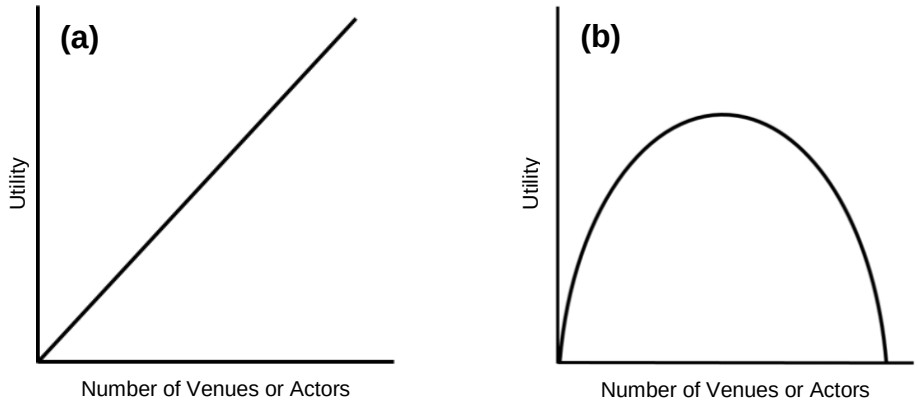


Figure 1: (a) Each additional actor and venue that actors engage with potentially provides benefits in the form of increased opportunities for collaboration, information sharing, and resource mobilization. (b) The constraints associated with participating in venues and collaborating with other actors, and the tradeoff actors make when deciding to engage with more actors and/or venues.

2.2 Time, complexity, and actor-venue relationships

We suspect a key variable influencing how actors decide which venues to participate in, and which other actors to collaborate with, is the time over which governance networks form. Existing research on public policy supports the notion that in nascent policy systems, or when new actors enter an existing policy system, it is typical for actors to focus on more immediate issues and experiment with engaging in different venues (Pralle 2003). Social learning enables actors to participate in more venues and collaborate with more other actors, as actors become more familiar with the particular policy and management issues that characterize the social-ecological system, as well as the set of actors and venues that make up the institutional setting (Pralle 2003). As a result of this learning process, actors are able to increase their capacity to engage with more venues and other actors over time (Fig. 2). In terms of (3), this means C increases, which implies an increase in the number of actors and venues a particular actor can engage with before the benefits level off. Hence, over time we expect the saturation threshold will increase (the dashed lines at t_1 and t_2 in Fig. 2), as actors are able to deliberate and strategize on how to manage more actor and venue relationships.

However, we do not assume that all actors in a given governance system will gather at the peak value as a large number of previous studies show that most networks are scale-free, meaning they are characterized by a skewed degree distribution where most actors have few ties, and few actors have many ties. Therefore, actors typically have varying numbers of social ties regardless of the capacity limitations, and often a limited number of actors possess significantly more ties than others (Gladwell 2006). In our empirical cases we do not assume all actors have the same number of social ties and venue engagements, but rather that most actors only have low to moderate numbers. Thus, we superimpose this assumed distribution of ties (and venues)

with the utility curves in Figure 2. This results in distribution curves that are still preserving the main characteristics where most actors have a lower number of ties. However, at $t = t_2$, we would expect a distribution that has shifted to the right (a "fatter tail"), whereas at $t = t_0$, the tail would quickly approach zero.

Using two empirical governance networks from Sweden, we test the hypothesis that the social activity of actors, measured as degree centrality (i.e., the number of ties to other actors), in collaborative governance networks varies uniformly as a function of time and complexity. Specifically, we expect actors will participate in more decision-making venues, and collaborate with other actors engaging in many venues, as the time over which the governance network forms increases. Support for our hypothesis will be indicated by the saturation threshold of actor degree centrality occurring at higher levels over time.

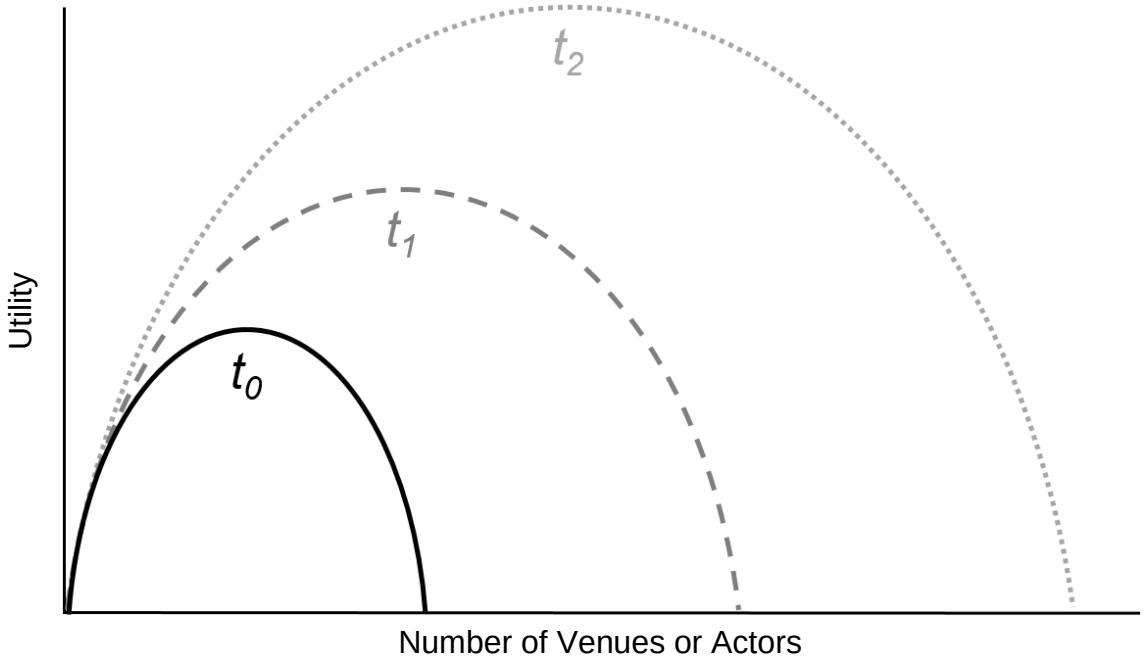


Figure 2: Conceptual diagram illustrating the hypothesized effects of the time-complexity mechanism on the capacity of actors to network with increasing numbers of venues and other actors to collaboratively govern social-ecological systems. As governance networks evolve over longer periods of time, the saturation threshold is expected to occur at higher levels, as social learning enables actors to engage with more venues and other actors.

3. Background

The empirical governance networks included in this study represent two regions of Sweden with distinct institutional and biophysical contexts, and vary in the time they formed. While a number of findings from these datasets have already been published, the research presented here uses these data in new ways to explore the relationship between the social activity of actors, their participation in decision-making venues, and their capacity for engaging with complex policy issues and management tasks.

3.1 Wildfire management in Västmanland, Sweden

The county of Västmanland is a largely rural, forested region in central Sweden. In the summer of 2014, Västmanland was the site of one of the largest wildfires in Sweden's recent history,

growing to over 15,000 hectares before being brought under control. Given the urgent need to develop and implement management plans to address this natural disaster, the network for managing the wildfire rapidly evolved over the course of days and weeks. Through semi-structured interviews and surveys, Bodin and Nohrstedt (2016) gathered data on individuals (n=74) involved in the wildfire response, and specific management tasks (n=11), which they used to build a multi-level network of the institutional response to managing the wildfire.

Management tasks, like decision-making venues, require collaboration and deliberation in order to design and implement a course of action with multiple participating actors. Furthermore, in spite of the context and severity of the governance challenges, nearly all actors had complete agency to choose which tasks they engaged in and which other actors they collaborated with. While actors were undoubtedly drawing on preexisting relationships and experience in making these decisions, perhaps surprisingly, few relationships in the institutional structure for responding to the wildfire were mandated.

3.2 Integrated coastal zone management in Bohuslän, Sweden

The province of Bohuslän is located along the North Sea coast in western Sweden, in the county of Västra Götaland. From 2008 to 2011, Bohuslän participated in an integrated coastal zone management (IZCM) project initiated by the Swedish Environmental Protection Agency (EPA), which involved developing an ecosystem-based management plan and building a regional governance network. The data were gathered using a mixed-method approach combining semi-structured interviews, a survey, and document review to identify individuals (n=56) and elicit both who they collaborated with and which venues (n=11) they participated in. This dataset was taken from a larger study of five different ICZM networks in Sweden, all participating in the EPA project, but only the dataset from Bohuslän contains network data comprising both actor and venue relations. A number of researchers participated in this effort, and a number of published works exist using these data (Sandström et al. 2014, Birnbaum et al. 2015, Borgström et al. 2015, Sandström et al. 2015, Bodin et al. 2016b).

Regarding the collaborative planning process, the actors could choose to participate in a series of different meetings, workshops and conferences. They could also choose, or in some cases were assigned to, certain working groups tasked with providing insights on specific management topics to the comprehensive planning document. The more significant events with regular meetings and deliberative processes were coded as different venues, and the actors that took part in these venues were then coded as participants.

4. Materials and methods

The two empirical network datasets used in the analysis here represent separate research projects with different objectives, conducted at different times, in different places, by different sets of researchers, and with different data collection methods. However, the common thread among the datasets is that each contains information about actor participation in decision-making venues and collaboration among actors, as well as information about the number of the policy issues and management tasks each actor engages with. Few empirical studies of environmental governance networks include all these specific types of data, all of which are needed to investigate the hypothesized time-complexity tradeoff actors face when deciding who to collaborate with and which venues to participate in.

4.1 Governance network composition and construction

In the two empirical governance networks from Västmanland and Bohuslän, we examine the association between the social activity of actors and actor participation in venues, and compare how the saturation of actor degree centrality is affected by tradeoffs in network formation time and the number of policy issues and management tasks actors engage with. We analyze both governance arrangements as undirected one-mode networks, where ties represent collaboration among actors, and the complexity of the policy issues and management tasks actors engage with through their participation in venues is included as a node attribute (Fig. 3). In both cases, each venue was designed to focus on one, and only one, policy issue or management task relevant to the particular social-ecological system. As such, actors choose to engage directly with more (less) complexity by participating in more (fewer) venues. In the wildfire management network in Västmanland, we measure complexity as the number of management tasks each actor participates in out of eleven possible tasks (e.g., logistics and supply, fire extinguishment, evacuation). Actor participation ranged from zero to eight tasks. In the ICZM network in Bohuslän, we similarly measure complexity as the number of decision-making venues each actor participates in out of eleven possible venues (e.g., fishing, water quality, recreational boating), and in this case participation ranged from zero to six venues.

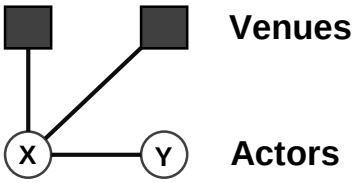


Figure 3: Conceptual diagram illustrating the structure of the datasets analyzed in this study. Actors are denoted as white circles, and venues as black squares. Only the actor-actor ties are used in the analysis of network structure, and actor-venue ties are used to measure the complexity of the policy issues and management tasks directly addressed by actors. In this example, Actor X engages with two policy issues or management tasks, while Actor Y does not directly address any.

4.2 Relationship between actor activity and complexity in governance networks

We measure the social activity of actors in the empirical governance networks using degree centrality, which is a node-level measure capturing the number of ties each actor possesses. More active actors have more collaborative ties with other actors. Instead of using the actual count of the number of ties, we use the normalized degree centrality – a fraction representing the ties each actor or venue possesses divided by the maximum possible ties (i.e., the number of nodes in the network minus one) – as it is easier to compare across networks with varying degree distributions. Combining this structural measure of actor activity with the issue and task complexity measure from each of the two empirical networks, we use linear regression to assess the correlation between the two variables for each actor in the networks. When these results are viewed with respect to network formation time, we hypothesize the saturation in the number of collaborators and venues actors engage with will occur at higher levels of complexity in governance networks that evolve over longer time periods.

More specifically, our hypothesis of actor activity and complexity over time anticipates a response that approximates an inverted U-shaped curve, as illustrated in Figure 2. We expect the saturation of actor engagement with venues and other actors will increase over time, but that every policy system will have its limits on the complexity of policy issues and management tasks that actors are willing to address. We fit a second-order polynomial trendline to the results for each of the two networks as a visual guide for estimating if and where the saturation

threshold is reached. In addition to the results of the regression analysis, we discuss a number of important qualitative characteristics of the data that help explain the behavior of the time-complexity mechanism in the empirical governance networks.

5. Results

The wildfire response network in Västmanland formed rapidly over several weeks, and represents the shortest network formation time of the two governance networks included in this study. The results (Fig. 4) indicate the majority (93%) of actors engage in four or fewer management tasks. This is also illustrated in the histogram (Fig. 5a), and is in line with previous findings of skewed degree distributions in empirical networks. Furthermore, the trendline suggests the association between actor degree and complexity increases from zero up to four management tasks. The degree of actors declines from five to eight tasks, but the presence of few actors engaging in many tasks warrants caution when interpreting the results. However, the distribution of the data is also important; the fact that so few actors engage in many tasks is indicative of actors being less willing to engage with complex policy issues and management tasks in the empirical system. In addition to this qualitative assessment, multi-level ERGM results presented by Bodin and Nohrstedt (2016) on the same network similarly indicate a general tendency for actors engaging in more tasks to possess fewer collaborative partners.

The ICZM network in Bohuslän formed over several years, and represents a more evolved governance system than the wildfire response network in Västmanland. The results indicate the majority (77%) of actors participate in four or fewer venues, and the regression analysis further suggests an increasing trend in the correlation between actor degree and complexity over the range of the data. Assuming our hypothesis is correct, what we are observing is the leading edge of the curve depicted in Figure 2, and the true point of saturation in actor activity may lie at or beyond the maximum value of six venues observed in Figure 4. Alternatively, the presence of one high-degree outlier participating in six venues may substantially skew the results. Regardless, given the presence of more actors engaging with many venues, the substantive interpretation of the findings from Bohuslän is that the actors in this governance network are more willing to engage with complex policy issues and management tasks than they are in the wildfire response network in Västmanland. This further confirmed in the histogram (Fig. 5b).

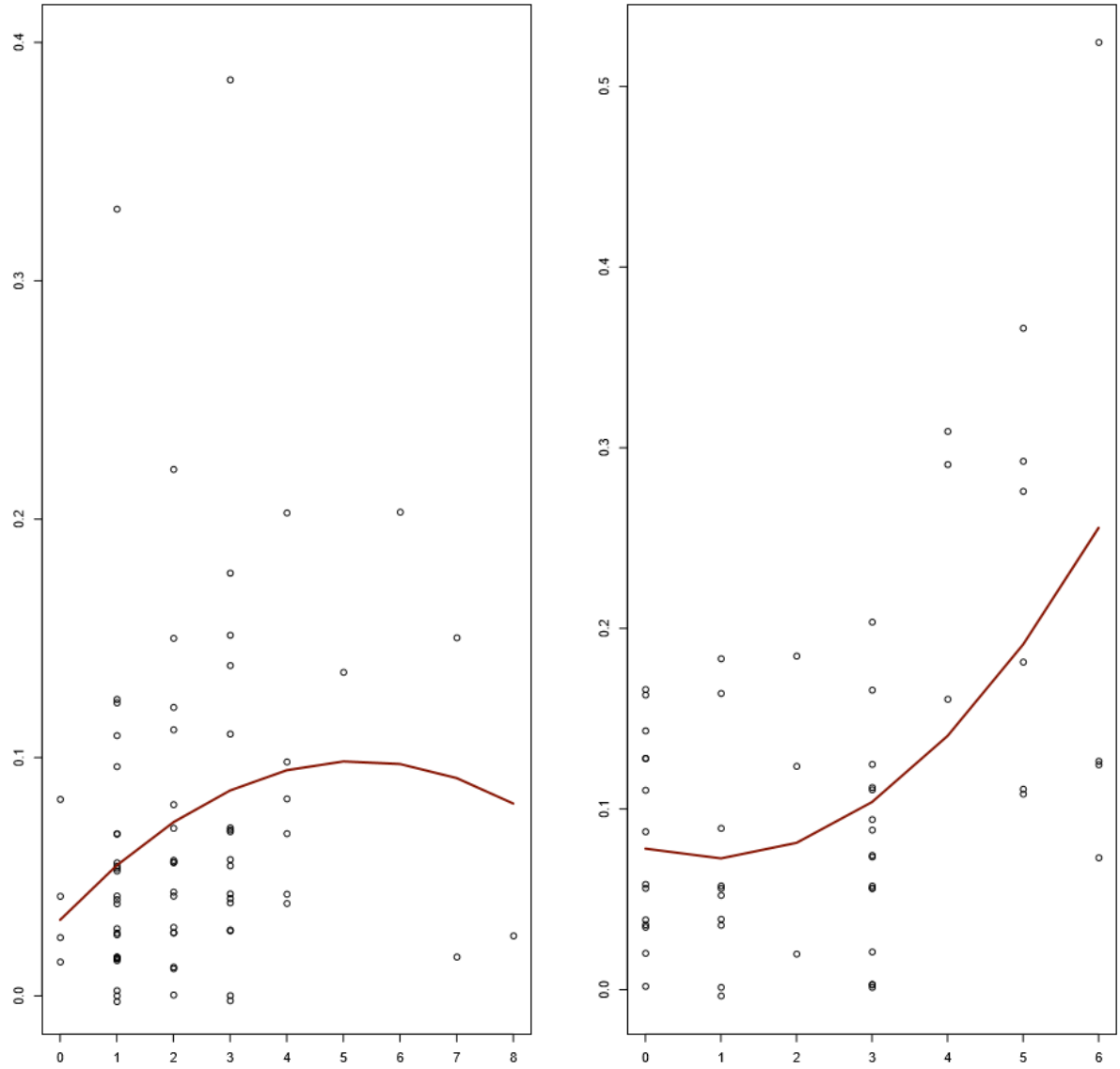
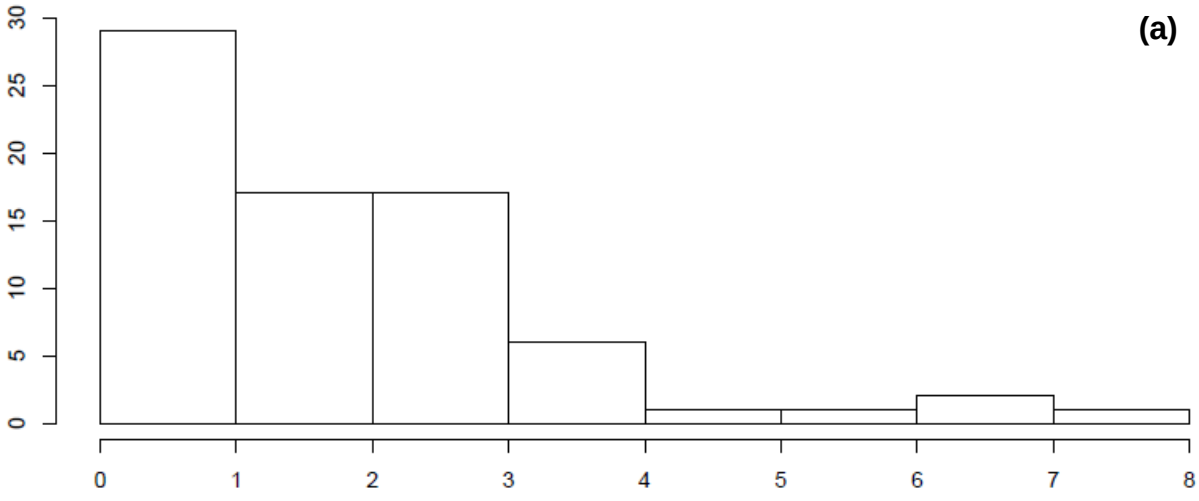


Figure 4: Graphical presentation of the results for actor degree centrality with respect to the number of policy issues and management tasks each actor engages in across the two empirical governance networks. Second-order polynomial trendlines are included primarily for visualization purposes.



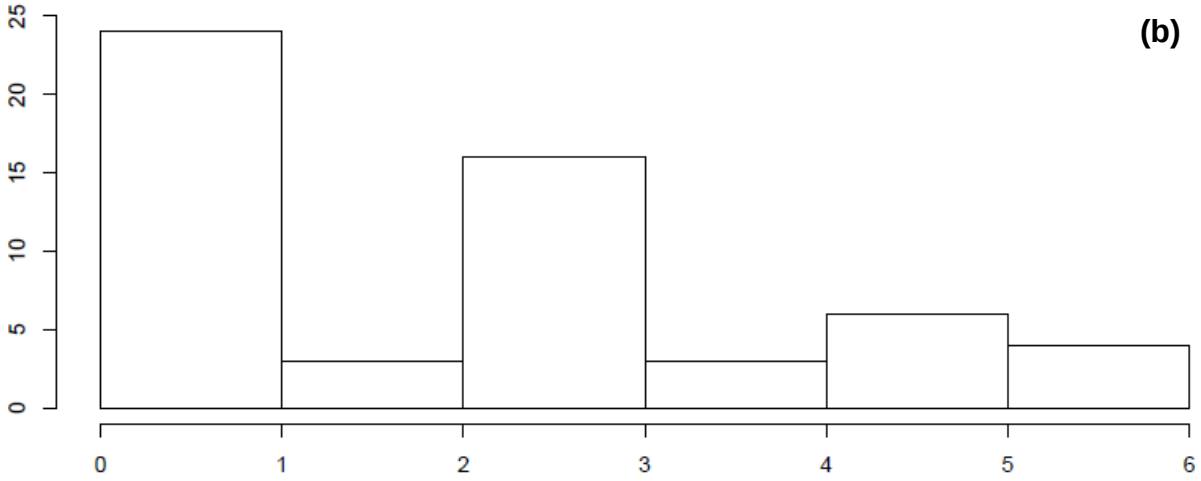


Figure 5: Histograms of the count of actors participating in a given number of venues in (a) the wildfire management network in Västmanland, and (b) the ICZM network in Bohuslän.

6. Discussion and conclusions

The empirical findings lend initial support to our hypothesis of a time-complexity tradeoff influencing the formation and evolution of networks for governing social-ecological systems. The results indicate the time over which governance networks form affects the decisions actors make with respect to which venues to participate in, and who to collaborate with, in uniform ways; the saturation in actor degree occurs at higher levels in networks that form over longer periods of time. This suggests that when given more time, actors are able to participate in more venues – as evidenced by the distribution of the data in Figures 4 and 5 – and that this occurs not too much at the expense of collaborating with other actors. However, while the results are indicative of this tradeoff, further research is needed across more, and more diverse, cases in order to provide stronger support for (or against) the hypothesized time-complexity tradeoff.

Possible explanations for the time-complexity tradeoff include the effects of cognitive limitations on actors' willingness to engage, directly and indirectly, with many policy issues and management tasks. Venues provide a structured way for actors to deal with complex issues in the governance of social-ecological systems, but engaging with more venues may not be feasible given constraints on time and cognitive resources. Similarly, the networking that occurs among actors to form social, or collaborative, ties provides an indirect way to engage in venues, and engaging with actors participating in many venues may not be desirable given the multitude of tasks vying for their attention. However, given actors engage in governance arrangements in order to influence the direction of management decisions, and ultimately outcomes, they have incentives to network with more actors and more venues.

The two datasets analyzed here were collected in different ways, and the separate studies focused on different sets of research questions. Rather than view this incongruence in methods as a barrier to comparison across the cases, the fact the data collection methods were different strengthens our assertion of a universal trend in the tradeoffs posed by time and complexity. While it would be preferable to sample the same governance network at multiple points in time, doing so was not an option given our reliance on existing empirical datasets, nor the intention of the paper, the primary of which was to conceptually explore the relationship between actor collaboration and venue participation in governance arrangements. However, given the preliminary findings, examining multiple networks over time should be an objective of future

empirical research in the area. Furthermore, we recognize not all governance systems will continue to evolve and mature in time, as this requires a steady and reliable stream of funding, and a modicum of institutional stability. However, it is beyond the scope and intention of this paper – not to mention the lack of data – to test address these issues here, and future research is needed to test the hypothesis in a more comprehensive and statistically robust fashion.

The empirical findings have important implications for the ability to achieve collective-action in most real-world settings, which are invariably characterized by complex patterns of social and ecological interdependencies. By shedding light on the various mechanisms that help shape collaborative governance arrangements – chiefly the factors that motivate actors to engage in particular venues and collaborate with select other actors – we improve our understanding of institutional "fit" in diverse resource systems. This is especially important given the benefits of policy and management actions across multiple institutions often fail to accumulate. Furthermore, as the number of complex policy issues and management tasks continue to increase in real-world social-ecological system, it is reasonable to assume more actors are required to overcome the cognitive and logistical deficit. Stated another way, we expect that no one actor, or small set of actors, will possess all the knowledge and resources needed to address a large and diverse range of policy issues and management tasks, and which may cover a sizeable region. However, we could also theorize that actor centrality may increase/decrease as a function of the nature of the governance processes being dealt with. For example, we may theorize the fire response network requires more coordination (highly central actors) to address urgent tasks efficiently. In contrast, we may expect the ICZM network to require more cooperation (dense clusters of actors) to formulate long-term policy and management strategies.

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